

WHAT IS CLAIMED IS:

1. An exposure apparatus comprising:
  - a projection system having an exposure field that is decentered with respect to an optical axis in order to project a pattern formed on a mask onto a photosensitive substrate;
  - 5 an illumination optical system that forms an illumination field on the mask, the illumination field being decentered with respect to the optical axis of the projection system;
  - a drive that relatively moves the mask and the photosensitive substrate along a scanning exposure direction with respect to the projection system;
  - 10 a first illumination adjustment mechanism that adjusts an illumination characteristic along the scanning exposure direction in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask;
  - a second illumination adjustment mechanism that adjusts an illumination characteristic in a direction crossing the scanning exposure direction in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask;
  - 15 a first telecentricity adjustment mechanism that applies an oblique component to telecentricity in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask; and
  - a second telecentricity adjustment mechanism that adjusts telecentricity changing in accordance with a position from the optical axis in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask.
2. The exposure apparatus of claim 1, wherein the illumination optical system forms an arcuate illumination field on the mask in the direction crossing the scanning exposure direction.
- 25 3. The exposure apparatus of claim 1, wherein the first illumination adjustment mechanism applies an illumination distribution component that is inclined along the scanning exposure direction, and the second illumination adjustment mechanism applies an illumination distribution component that is inclined along the direction crossing the scanning exposure direction.
- 30 4. The exposure apparatus of claim 1, wherein the illumination optical system includes a plurality of illumination optical components, and the first and second illumination

adjustment mechanisms move or incline at least one common illumination optical component among the plurality of illumination optical components in mutually different directions.

5        5.        The exposure apparatus of claim 4, wherein the first telecentricity adjustment mechanism adjusts an illumination optical component that is different from an illumination optical component that is adjusted by the first and second illumination adjustment mechanisms, and the second telecentricity adjustment mechanism adjusts an illumination optical component that is different from the illumination optical component adjusted by the first telecentricity adjustment mechanism.

10        6.        The exposure apparatus of claim 4, wherein the first telecentricity adjustment mechanism adjusts an illumination optical component that is different from an illumination optical component that is adjusted by the first and second illumination adjustment mechanisms, and the second telecentricity adjustment mechanism adjusts an illumination optical component that is the same as the illumination optical component adjusted by the first telecentricity adjustment mechanism.

15        7.        The exposure apparatus of claim 1, wherein the illumination optical system includes a plurality of illumination optical components, and the first and second illumination adjustment mechanisms move or incline mutually different optical components among the plurality of illumination optical components in mutually different directions.

20        8.        The exposure apparatus of claim 7, wherein the first telecentricity adjustment mechanism adjusts an illumination optical component that is different from an illumination optical component that is adjusted by the first and second illumination adjustment mechanisms, and the second telecentricity adjustment mechanism adjusts an illumination optical component that is different from the illumination optical component adjusted by the first telecentricity adjustment mechanism.

25        9.        The exposure apparatus of claim 7, wherein the first telecentricity adjustment mechanism adjusts an illumination optical component that is different from an illumination optical component that is adjusted by the first and second illumination adjustment mechanisms, and the second telecentricity adjustment mechanism adjusts an illumination optical component that is the same as the illumination optical component adjusted by the first telecentricity adjustment mechanism.

30        10.       The exposure apparatus of claim 1, wherein the illumination optical system includes a plurality of reflective components, and the first illumination adjustment

mechanism, the second illumination adjustment mechanism, the first telecentricity adjustment mechanism, and the second telecentricity adjustment mechanism respectively adjust a position of at least some of the reflective components of the illumination optical system.

11. The exposure apparatus of claim 10, wherein the first and second illumination adjustment mechanisms incline a common reflective component about mutually different axes of rotation.

12. The exposure apparatus of claim 10, wherein the first and second telecentricity adjustment mechanisms move the same reflective component in mutually different directions.

13. The exposure apparatus of claim 10, wherein the first and second illumination adjustment mechanisms move a common reflective component in different directions.

14. The exposure apparatus of claim 11, wherein the first and second telecentricity adjustment mechanisms move the same reflective component in mutually different directions.

15. The exposure apparatus of claim 14, wherein the first and second illumination adjustment mechanism adjust a reflective component that is different from a reflective component adjusted by the first and second telecentricity adjustment mechanisms.

16. The exposure apparatus of claim 1, wherein the illumination optical system comprises:

a light source that outputs the light beam;

a reflective optical integrator that makes uniform an illumination distribution of light from the light beam; and

a light guiding optical system arranged between the light source and the reflective optical integrator, and that guides the light beam from the light source to the reflective optical integrator.

17. The exposure apparatus of claim 1, further comprising an illumination condition changing mechanism that changes an illumination condition in the illumination field formed on the mask, or in the exposure field of the projection system formed on the photosensitive substrate; and wherein:

the first illumination adjustment mechanism, the second illumination adjustment mechanism, the first telecentricity adjustment mechanism and the second telecentricity adjustment mechanism perform their respective adjustments according to a change of the illumination condition made by the illumination condition changing mechanism.

18. A method of fabricating a micro-device utilizing the exposure apparatus of claim 1, comprising the steps of:

illuminating the mask using the illumination optical system of claim 1; and

exposing an image of the pattern of the mask onto the photosensitive substrate

using the projection system of claim 1.

19. An exposure apparatus comprising:

an illumination optical system having a plurality of reflective components that guide a light beam to a mask;

a projection system that projects a pattern of the mask onto a photosensitive substrate;

a drive that relatively moves the photosensitive substrate and the mask with respect to the projection system along a specified scanning exposure direction;

a first telecentricity adjustment mechanism that applies an oblique component to telecentricity in one of: (a) an exposure field of the projection system, and (b) an illumination field formed on the mask; and

a second telecentricity adjustment mechanism that adjusts telecentricity changing in accordance with a position from an optical axis in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask;

wherein the first and second telecentricity adjustment mechanisms respectively adjust at least some of the plurality of reflective components of the illumination optical system

20. The exposure apparatus of claim 19, wherein the second telecentricity adjustment mechanism moves a reflective component that is adjusted by the first telecentricity adjustment mechanism in a direction different from a direction in which the reflective component is moved by the first telecentricity adjustment mechanism.

21. The exposure apparatus of claim 19, wherein the second telecentricity adjustment mechanism moves a reflective component that is different from a reflective component that is adjusted by the first telecentricity adjustment mechanism in a direction different from a direction in which the reflective component is moved by the first telecentricity adjustment mechanism.

22. The exposure apparatus of claim 19, wherein the illumination optical system comprises:

a light source that outputs the light beam;  
a reflective integrator that makes uniform an illumination distribution of light from the light beam on the photosensitive substrate or the mask; and  
a light guiding optical system arranged between the light source and the reflective integrator that guides the light beam from the light source to the reflective integrator.

23. The exposure apparatus of claim 19, wherein the projection system includes an exposure field that is decentered with respect to the optical axis, and the illumination optical system forms the illumination field at a position on the mask that is decentered with respect to the optical axis of the projection system.

24. The exposure apparatus of claim 19, further comprising an illumination condition changing mechanism that changes an illumination condition in the illumination field formed on the mask, or an illumination condition in the exposure field of the projection system formed on the photosensitive substrate, and wherein:

the first telecentricity adjustment mechanism and the second telecentricity adjustment mechanism perform their respective adjustments according to the change of the illumination condition made by the illumination condition changing mechanism.

25. A method of fabricating a micro-device utilizing the exposure apparatus of claim 19, comprising the steps of:

illuminating the mask using the illumination optical system of claim 19; and  
exposing an image of the pattern of the mask onto the photosensitive substrate using the projection system of claim 19.

26. A method of exposing a pattern of a mask onto a photosensitive substrate, the method comprising the steps of:

forming an illumination field on the mask, the illumination field being decentered with respect to an optical axis of a projection system;

projecting the pattern of the mask onto the photosensitive substrate with the projection system, the projection system having an exposure field that is decentered with respect to the optical axis;

relatively moving the mask and the photosensitive substrate along a scanning exposure direction with respect to the projection system;

adjusting an illumination characteristic along the scanning exposure direction in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask;

adjusting an illumination characteristic in a direction crossing the scanning exposure direction in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask;

applying an oblique component to telecentricity in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask; and

adjusting telecentricity changing in accordance with a position from the optical axis in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask.

27. The method of claim 26, wherein the illumination optical system forms an arcuate illumination field on the mask in the direction crossing the scanning exposure direction.

28. The method of claim 26, wherein the illumination characteristic along the scanning exposure direction is adjusted by applying an illumination distribution component that is inclined along the scanning exposure direction, and the illumination characteristic in the direction crossing the scanning exposure direction is adjusted by applying an illumination distribution component that is inclined along the direction crossing the scanning exposure direction.

29. The method of claim 26, wherein the illumination optical system includes a plurality of illumination optical components, and the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction are adjusted by moving or inclining at least one common illumination optical component among the plurality of illumination optical components in mutually different directions.

30. The method of claim 29, wherein the oblique component to telecentricity is applied by adjusting an illumination optical component that is different from the at least one common illumination optical component, and the telecentricity changing in accordance with a position from the optical axis is adjusted by adjusting an illumination optical component that is different from the illumination optical component adjusted to apply the oblique component to telecentricity.

31. The method of claim 29, wherein the oblique component to telecentricity is applied by adjusting an illumination optical component that is different from the at least one common illumination optical component, and the telecentricity changing in accordance with a position from the optical axis is adjusted by adjusting an illumination optical component that is the same as the illumination optical component adjusted to apply the oblique component to telecentricity.

32. The method of claim 26, wherein the illumination optical system includes a plurality of illumination optical components, and the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction are adjusted by moving or inclining different illumination optical components among the plurality of illumination optical components in mutually different directions.

33. The method of claim 32, wherein the oblique component to telecentricity is applied by adjusting an illumination optical component that is different from the at least one common illumination optical component, and the telecentricity changing in accordance with a position from the optical axis is adjusted by adjusting an illumination optical component that is different from the illumination optical component adjusted to apply the oblique component to telecentricity.

34. The method of claim 32, wherein the oblique component to telecentricity is applied by adjusting an illumination optical component that is different from the at least one common illumination optical component, and the telecentricity changing in accordance with a position from the optical axis is adjusted by adjusting an illumination optical component that is the same as the illumination optical component adjusted to apply the oblique component to telecentricity.

35. The method of claim 26, wherein the illumination optical system includes a plurality of reflective components, and the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction, the oblique component to telecentricity, and the telecentricity changing in accordance with a position from the optical axis are adjusted by adjusting a position of at least some of the reflective components of the illumination optical system.

36. The method of claim 35, wherein the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction

are adjusted by inclining a common reflective component about mutually different axes of rotation.

37. The method of claim 35, wherein the oblique component to telecentricity and the telecentricity changing in accordance with a position from the optical axis are adjusted by moving the same reflective component in mutually different directions.

38. The method of claim 35, wherein the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction are adjusted by moving a common reflective component in different directions.

39. The method of claim 36, wherein the oblique component to telecentricity and the telecentricity changing in accordance with a position from the optical axis are adjusted by moving the same reflective component in mutually different directions.

40. The method of claim 39, wherein the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction are adjusted by adjusting a reflective component that is different from a reflective component moved to adjust the oblique component to telecentricity and the telecentricity changing in accordance with a position from the optical axis.

41. The method of claim 26, further comprising:  
changing an illumination condition in the illumination field formed on the mask, or in the exposure field of the projection system formed on the photosensitive substrate; and wherein:

the illumination characteristics along the scanning exposure direction and along the direction crossing the scanning exposure direction, the oblique component to telecentricity, and the telecentricity changing in accordance with a position from the optical axis are adjusted according to the change made to the illumination condition.

42. A method of exposing a pattern of a mask onto a photosensitive substrate, the method comprising the steps of:

forming an illumination field on the mask, the illumination field being decentered with respect to an optical axis of a projection system;

projecting the pattern of the mask onto the photosensitive substrate with the projection system, the projection system having an exposure field that is decentered with respect to the optical axis;



relatively moving the mask and the photosensitive substrate along a scanning exposure direction with respect to the projection system;

applying an oblique component to telecentricity in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask; and

5 adjusting telecentricity changing in accordance with a position from the optical axis in one of: (a) the exposure field of the projection system, and (b) the illumination field formed on the mask;

wherein the oblique component to telecentricity and the telecentricity changing in accordance with a position from the optical axis are adjusted by moving at least  
10 some of the plurality of reflective components of the illumination optical system.

43. The method of claim 42, wherein the oblique component to telecentricity is adjusted by moving a reflective component in a direction different from a direction in which the reflective component is moved in order to adjust the telecentricity changing in accordance with a position from the optical axis.

44. The method of claim 42, wherein the oblique component to telecentricity is adjusted by moving a reflective component that is different from a reflective component that is moved in order to adjust the telecentricity changing in accordance with a position from the optical axis.

45. The method of claim 42, wherein the projection system includes an exposure field that is decentered with respect to the optical axis, and the illumination optical system forms the illumination field at a position on the mask that is decentered with respect to the optical axis of the projection system.

46. The method of claim 42, further comprising:  
changing an illumination condition in the illumination field formed on the  
25 mask, or an illumination condition in the exposure field of the projection system formed on the photosensitive substrate, and wherein:

the oblique component to telecentricity and the telecentricity changing in accordance with a position from the optical axis are adjusted according to the change made to the illumination condition.

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9/5